

ORIENTED OVERLAND SPRING MIGRATION OF PINIONED CANADA GEESE

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SEVERAL attempts have been made to re-establish breeding flocks of Canada Geese (*Branta canadensis*) on former nesting ranges in the north-central states. In recent years the United States Fish and Wildlife Service has trapped both young and adult wild birds and released them as pinioned adults in large enclosures on potential breeding marshes. Geese were trapped from the fall concentration at Swan Lake National Wildlife Refuge at Sumner, Missouri. Band returns suggest that these birds are from the Eastern Prairie population of *B. c. interior* whose breeding range centers along the western edge of Hudson Bay between Fort Severn and Fort York (Hanson and Smith, 1950).

In the years following restocking of refuges in Minnesota, Nebraska, and North and South Dakota, no pair-formation or nesting occurred, even though most of the birds reached a minimum age of five years. Birds that escaped from the enclosures, or that were liberated in unfenced marshes, showed a definite tendency to move northward. This paper documents the nature and extent of these overland spring movements by flightless geese.

OBSERVATIONS

In the following discussion, northward movements are described in terms of distance and direction of travel. The true azimuth from the point of release to the sighting or recovery is reported in parentheses following the record. Thus, 360° means a movement directly to the north, 010° a movement 10 degrees east of north. When satisfactory evidence indicates that the observation is of a previously reported group, the azimuth is from the last sighting. The magnetic deviation for this area is about 11° east.

Mud Lake Refuge, Holt, Minnesota.—Over 100 pinioned captive Canada Geese, primarily birds wild-trapped at Swan Lake in 1951 and 1952, were being held at the Mud Lake Refuge in 1955. Shortly before May 20, 1955, 60 to 70 of these geese escaped from their pen. On May 20 and May 31 several birds from the flock were recaptured by refuge personnel in a field on the open prairie 6 miles north of the pen (360°). Some of those birds which escaped were later sighted in a field a half mile south of Thief Lake, 10 miles north of the release pen (011°). None of these birds were recaptured and apparently all perished during the hunting season that fall. The point of escape did not connect directly to any watercourse, and the intermediate sightings and recaptures in open farmland suggest that the Thief River to the east was not used as a travel route. Thief Lake was not visible to the birds from the pen.

Valentine Refuge, Valentine, Nebraska.—With the clearing of ice in April, 1956, 50 geese from Swan Lake were released from an 11-acre pen at Pony Lake on the Valentine Refuge. In May two groups of geese (9 and 16 individuals) were recaptured on the

southern end of Ballard State Marsh, 6.9 (358°) and 6.4 (006°) miles north of Pony Lake. Of the 25 remaining geese, 16 were recaptured in the fall of 1956 on South Marsh Lake, just to the northeast of Pony Lake. Since several geese were sighted north of the Marsh Lakes on Red Deer Lake after the May recapture, it is possible that some of the autumn South Marsh Lake recoveries had returned overland from a more northern area. In April, 1957, 72 geese, including some of the participants in the 1956 movement, were released at Pony Lake. After a few days of delay the flock traveled across the Marsh Lakes and overland to the north. Two birds were recovered on a small temporary pond 9.1 miles (019°) from the release site and the remaining flock of 67 birds was recaptured on rolling ranchland 3.6 miles farther north (359°), 12.7 air miles from the initial release site. In both years the initial movement away from Pony Lake was through an elevated pass to the northeast in spite of a more accessible lowland escape route to the southeast. Having thus reached the Marsh Lakes, water and marshland may have facilitated and directed the movement for the next 3 miles before high country and restricted visibility were again encountered. The final 6 miles of the movement in 1957 passed through rolling hills devoid of natural water sources.

Crescent Lake Refuge, Ellsworth, Nebraska.—In late May of 1957 approximately 120 geese escaped from the pen at refuge headquarters. The majority of these birds were recaptured 2.7 miles to the north (356°) on June 2, 1957. On that date they were still moving north. Near the escape site visible water lay only to the south, yet the initial route took the birds nearly a mile overland to Goose Lake and from there the movement again struck into waterless open country to the north. A chain of lakes to the northeast of Goose Lake would have combined a watercourse with a generally northward (approximately 050°) route, yet the movement did not deflect in that direction.

Arrowwood Refuge, Kensal, North Dakota.—A flock of Swan Lake birds was released from a holding pen adjoining Jim Lake on April 17, 1957. On May 26, 17 of these birds were sighted on the James River 10.8 miles north (353°) of the release site. Several birds, presumably the same group, were sighted on June 17, 6.8 miles north (355°) of the last sighting, and on June 24, 17 geese were captured 3.3 miles still farther north (347°). On May 1, 1958, 24 or 25 geese, including some of the birds recovered from the previous year's migration, escaped from the Jim Lake holding compound. On May 7 three geese were recaptured 2.0 miles north (005°) of the pen. Ten pinioned geese were sighted on May 22 at the point of the May 26, 1957, sighting (353°). On June 4 a farmer reported nine geese in a slough 3.6 miles northeast of the release site (056°), and on June 20 another report located two geese 7.3 miles from the release site (088°). On June 10, and in the following days, between 12 and 18 pinioned geese were reported on the James River east of Grace City, 24.8 miles from the point of release (002°). This undoubtedly included the birds sighted May 22. Much of the movement in 1957 probably followed the course of the James River and its impoundments (Jim Lake, Arrowwood Lake), but both the June 17 and June 24 sightings were away from the river and its tributaries. The main body of the 1958 migration probably also followed the waterways of the James River to the point of the June 10 sighting. It is interesting to note that the location of this sighting was on the north side of the river just past the first point beyond the release site where the river course deviated significantly for any great distance from a generally north-south direction. Where the river turned to the west progress ended. Perhaps further movement to the north was limited by the reluctance of the birds to cross the bed of the Great Northern Railway. The birds recaptured May 7 apparently made the entire journey overland, in spite of the northwesterly course

available on nearby Jim Lake. The birds sighted June 4 and 20 must also have moved almost entirely overland.

Lacreek Refuge, Martin, South Dakota.—On March 21, 1957, approximately 47 Swan Lake birds were released. They remained at the release point until the first week in May when about 32 birds moved out. The first 5 miles of migration was probably over a chain of lakes to the north. Movement to the location of recoveries farther to the north could only have been accomplished by considerable overland movement. On May 29, 1957, 16 geese were recaptured at a stock pond 17.6 miles from the release point (356°) and 11.3 miles beyond the last waterway. Five geese were recaptured in an alfalfa field on June 4, 13.7 air miles (353°) from the release site and 8.1 miles beyond a potentially guiding watercourse. Two other recaptures of three and two birds were made to the north of the release site (333° , 017°).

The results of these observations are summarized in Fig. 1. In addition to the actual movements recorded above, penned birds at Lostwood (North Dakota) and Crescent Lake (Nebraska) refuges regularly crowded the north fence lines in spring and early summer.

DISCUSSION

Timing of migration.—The period of passage for wild Canada Geese at the pertinent refuges is recorded in Table 1, together with the period of movement of the pinioned birds. From these data it is at once apparent that the movement of the pinioned birds started later and continued longer than the natural migration through the area. This can not be accounted for by the tardy release of the captives, since at least one flock (Lacreek) did not initiate movement until over a month after release.

The protracted migration period, well into June, perhaps bears out Merckel's (1956) suggestion that the experiences of birds are important in ending migration once the breeding grounds are reached. The nature of this experience, whether recognition of familiar country, celestial cues or some other change, and how it acts to end migration are two of the many unsolved mysteries of bird migration. The transportation and observation of land-bound geese might be a productive method of investigating this problem.

Rate of movement.—Table 2 summarizes those parts of the movements for which the rate of advance by pinioned birds could be accurately determined. The distance traveled per day was found by dividing air distance traveled since the last sighting by the number of intervening days. Some error is thus inherent in these calculations due to differential underestimation of the length of the actual path taken. Observations 2, 6, and 7 represent the progress of the 1957 Arrowwood release, and records 3 and 5 both represent the same fragment of the 1958 Arrowwood release. For these flocks for which more than one report is available there is no indication of a slowing of the movement late in the season when the natural migration of Canada Geese through the area had ended. If the data for all localities are taken together the result

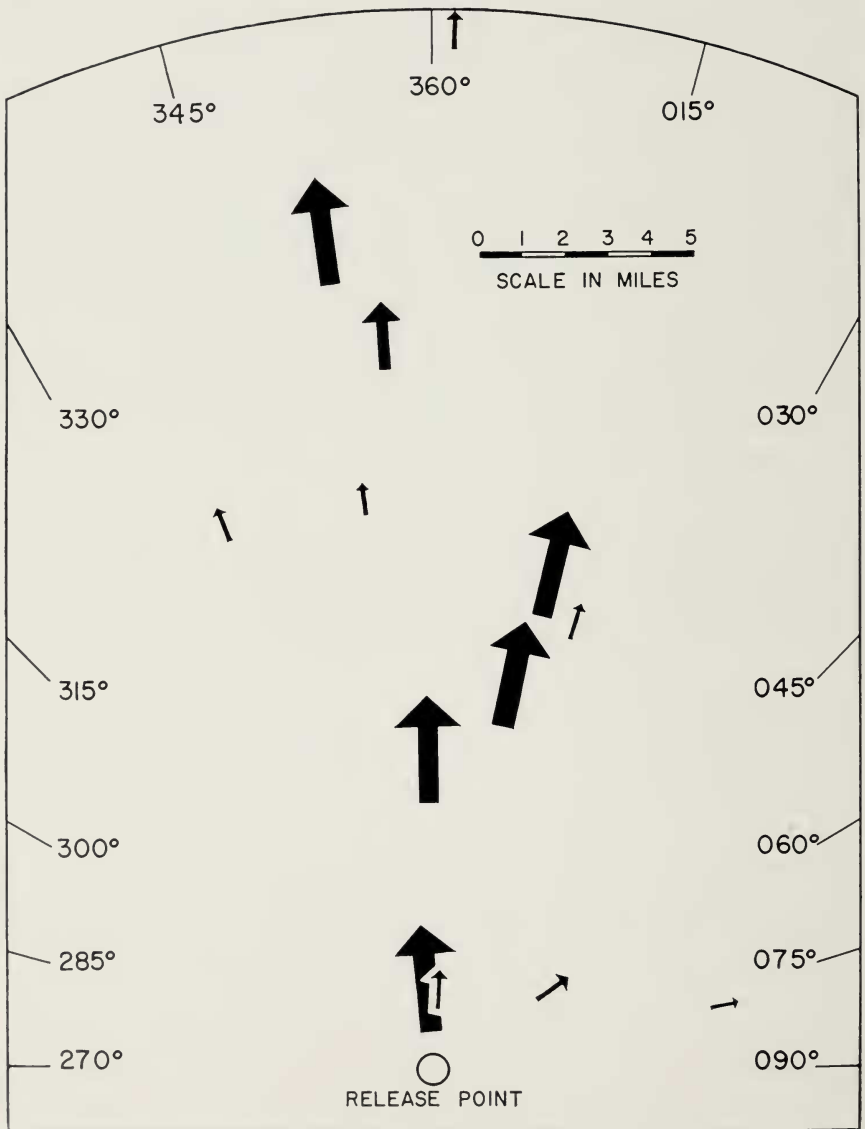


FIG. 1. True compass direction taken by migrating pinioned Canada Geese. The heaviest arrows represent flocks which did not fragment in their movement, the smaller arrows portions of fragmented flocks.

is the same, i.e., no indication of a slowing of the walking migration up to the time the birds were recaptured.

Orientation of migration.—Fig. 1 clearly establishes the northward move-

TABLE 1
TIMING OF MIGRATION OF WILD AND PINIONED CANADA GEES

Refuge	First arrivals	Main migration	Release of captives	Movement of captives
Mud Lake	3/30/55	4/10 to 4/16/55	5/19 ± 2/55	5/19 to 5/31/55
Arrowwood	3/17/57	4/21/57	5/17/57	until 6/24/57
	3/24/58	4/4 to 4/7/58	5/1/58	5/1 to 6/10/58
Lacreek	2/13/57	3/3 to 3/4/57	3/21/57	5/4 ± 3 to 5/29/57
Crescent Lake	2/17/57	3/10 to 3/23/57	5/20 ± 5/57	until 6/2/57

ment of the released birds during May and June. The conditions of transplantation and release allow some opportunity for analysis of the directional cues which may have been utilized in these movements. Since all the Swan Lake birds had migrated at least once it is possible that some of the birds were familiar with the terrain over which they moved and were following familiar landmarks in an attempt to return to a familiar northern breeding area. But the use of remembered landmarks seems unlikely when we recall the limited horizon of visibility available to a bird with its head less than a meter from the ground and the different perspective from this position.

Recent investigations have demonstrated celestial orientation in a wide variety of avian species (Kramer, 1957; Sauer, 1957), including several species of waterfowl. With his special technique of releasing and following free-flying waterfowl, Bellrose (1958 and personal communication) has recently obtained evidence that the Canada Goose is capable of utilizing celestial cues. Thus, for this species, it is at least possible that the celestial environment was the orienting cue.

The direction of overhead passage of wild migrants could also have provided the necessary orienting cues, at least for the initial movement. Table 3 compares the direction taken by wild migrants and walking geese with the

TABLE 2
RATE OF MIGRATION OF PINIONED CANADA GEES

Observation number	Refuge	Mean travel date	Date of movement	Nature of terrain	Average miles/day	True azimuth
1	Arrowwood	5/4	5/1 to 5/7/58	overland	.33	005°
2	Arrowwood	5/6	4/17 to 5/26/57	waterways	.36	353°
3	Arrowwood	5/11	5/1 to 5/22/58	waterways	.51	353°
4	Mud Lake	5/25	5/19 to 5/31/55	overland	.50	011°
5	Arrowwood	6/1	5/22 to 6/10/58	waterways	.74	010°
6	Arrowwood	6/6	5/26 to 6/17/57	both	.31	355°
7	Arrowwood	6/20	6/17 to 6/24/57	overland	.47	347°

TABLE 3
DIRECTION TAKEN BY FREE-FLYING AND PINIONED CANADA GEESE

Refuge	Direction of overhead migrants	Miles to probable breeding grounds	True azimuth to probable breeding grounds	Direction taken by walking geese
Mud Lake	Due north	700	$011^{\circ} \pm 10^{\circ}$	$360^{\circ}, 011^{\circ}$
Arrowwood	North to northwest	800	$019^{\circ} \pm 11^{\circ}$	$355^{\circ}, 353^{\circ}, 353^{\circ}, 347^{\circ}, 002^{\circ}, 005^{\circ}, 056^{\circ}, 088^{\circ}$
Lacreek	Almost due north	1100	$016^{\circ} \pm 8^{\circ}$	$356^{\circ}, 353^{\circ}, 333^{\circ}, 017^{\circ}$
Valentine	—	1100	$018^{\circ} \pm 7^{\circ}$	$359^{\circ}, 358^{\circ}, 006^{\circ}, 019^{\circ}$
Crescent Lake	North	1250	$016^{\circ} \pm 8^{\circ}$	356°

direction to the probable breeding grounds. Such a mimetic mechanism of orientation would not be unexpected in this species where social behavior is such a significant feature of migration, and where tradition has been shown to play a major role in some features of travel (Hochbaum, 1955). However, such overhead migration could not have been the sole orienting cue since much of the oriented movement took place after natural migration had ended.

The importance of guides could conceivably be experimentally investigated by comparing the accuracy of orientation of pinioned birds on relatively featureless terrain with and without overhead migrants. Furthermore, if a bird will orient appropriately while walking over the ground, then some birds could be repeatedly utilized to test diurnal and seasonal variation in intensity and accuracy of orientation. Such a technique could go beyond caged *Zugunruhe* studies in testing the influence of the visual environment, particularly habitat changes and responses to them. In suitably homogeneous terrain celestial orientation responses could be tested in those species which can not be shown to demonstrate directional *Zugunruhe* responses in small cages. But more important, features of social organization and leadership, heretofore largely neglected in experimental studies, might be investigated.

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SUMMARY

Adult pinioned Canada Geese escaped or were released at several National Wildlife Refuges in Minnesota, Nebraska, and the Dakotas, well south of the

natural breeding range of this population. Subsequent sightings and recoveries indicate an accurate northward movement of these earth-bound birds during and after the period of normal goose migration. Overland movements up to 24.8 air miles were recorded. The rate of progress was more or less uniform throughout the season, ranging from .31 to .74 miles per day. The cues guiding the birds northward are not known, but some possibilities are discussed.

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